First record of the genus *Morophaga* Herrich-Schäffer (Lepidoptera, Tineidae) from the Ogasawara Islands, Japan, with a new species

Jinhyeong Park[1], Sadahisa Yagi[2,3], Toshiya Hirowatari[3,4]

1 *Entomological Laboratory, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan; parkjinhyeong19990929@gmail.com*

2 *Insect DX laboratory, Faculty of Agriculture, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan; yagi.sadahisa@gmail.com*

3 *Insect Science and Creative Entomology Center, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan; hirowat_t@agr.kyushu-u.ac.jp*

4 *Entomological Laboratory, Faculty of Agriculture, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan*

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Abstract. The present study records *Morophaga formosana* Robinson, 1986 and describes *M. hahajimana* **sp. nov.** from the Ogasawara Islands of Japan. This is the first record of this genus *Morophaga* Herrich-Schäffer, 1853 (Tineidae) from the Oceanian region. Photographs of adult specimens, wing veins, genitalia, and larval biology are presented. We have constructed a preliminary phylogenetic tree based on cytochrome c oxidase subunit I (COI-5P) DNA barcode sequences, including those of some Scardiinae species.

Introduction

The Ogasawara Islands, also known as the Bonin Islands, are oceanic islands located approximately 1,000 km south of Tokyo, Japan. This area belongs to the Oceanian Region, which has a biota different from that of mainland Japan. Approximately 270 species of moths have been recorded from the Ogasawara Islands (Nakajima and Nishikai 2021); however, knowledge of species diversity in detritivorous microlepidopterans, such as Tineidae, is fragmented (Takeuchi and Ohbayashi 2006).

The genus *Morophaga* Herrich-Schäffer, 1853 currently includes 17 described species (Robinson and Nielsen 1993; Ponomarenko and Park 1996; Osada and Hirowatari 2016) and is known from the Palearctic, Afrotropical, Oriental, and Australian regions, but is absent from the New World and Oceanian regions. In this genus, five groups have been proposed: the *bucephala*-, the *morellus*-, the *sistrata*-, the *clonodes*, and the *choragella*-groups (Robinson 1986). In Japan, six species have been reported: *M. parabucephala* Ponomarenko & Park, 1996; *M. bucephala* (Snellen, 1884) (the *bucephala*-group); *M. fasciculata* Robinson, 1986; *M. plana* Osada & Hirowatari, 2016 (the *choragella*-group); *M. formosana* Robinson, 1986; and *M. iriomotensis* Robinson, 1986 (the *sistrata*-group) (Sakai 2013; Osada and Hirowatari 2016). All species of *Morophaga* are fungivorous, and some are known to feed on bark with fungi on it (Robinson and Nielsen 1993). This dietary habit makes some species of this genus a pest in shiitake mushroom cultivation (Osada and Yoshimatsu 2017).

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Prior to this study, no *Morophaga* species had been recorded in the Ogasawara Islands or the Oceanian region. During this study, we have identified two *Morophaga* species, one of which does not match any known species. In this paper, we describe one species as *Morophaga hahajimana* sp. nov. and record the other as *M. formosana* Robinson, 1986. We also provide information on the habitat and biology of this new species.

Methods

Sampling and dissection

Specimens were collected using an LED UV lamp and mercury lamp at night (light trapping, LT), a light flight interception trap (LTFIT), and by rearing larvae from the host. The collected host (fruiting bodies of fungi and rotten wood) with larvae were stored in a food storage bag with seals (DAISO, Hiroshima, Japan) at room temperature. The specimens collected in this study were deposited at the Entomological Laboratory of Kyushu University (ELKU).

Images of adults were obtained using a SONY α7R IV digital camera (SONY, Tokyo, Japan) fitted with a CANON MP-E 65 mm macro lens (CANON, Tokyo, Japan).

Specimens were dissected and observed under a Nikon SMZ-U stereomicroscope (Nikon, Tokyo, Japan). To examine male and female genitalia, the abdomens of specimens were removed and boiled in a 10% KOH solution for approximately 10 min. After washing with 70% ethanol, the genitalia were dissected in 70% ethanol and stained with a Chlorazol Black E solution. After dehydration by soaking in different concentrations of ethanol, from 70% to 99% for at least one hour, the genitalia were mounted it in Euparal on glass slides. Wing venation was observed after preparation. Detached wings were removed scales using a soft hairbrush and Kimwipe s-200 (NIPPON PAPER CRECIA CO., LTD, Tokyo, Japan) with 70–75% ethanol (EtOH) solution, stained with a mercurochrome solution for more than one day, and dehydrated using serial dilutions of 70–99% EtOH, and mounted in Euparal on glass slides.

Genital images were captured using a Canon EOS 90D digital camera (CANON, Tokyo, Japan) connected to a Nikon ECLIPSE Ci-L stereomicroscope (Nikon, Tokyo, Japan). Photographs were processed using Adobe Photoshop v26.4.1 (2024).

DNA extraction, PCR amplification, and sequencing

DNA analysis was performed in order to infer phylogenetic relationships and closely related species in the partial mitochondrial cytochrome oxidase subunit I (COI) region (DNA barcode region).

Adult specimens of *M. hahajimana* sp. nov., *M. formosana*, *M. fasciculata*, and *Erechthias zebrina* (Butler, 1881) (as an outgroup) were used for DNA extraction using the DNeasy Blood and Tissue Kit (Qiagen, Netherlands) (Table 1). Total DNA was extracted from the abdomen of the moths using a kit protocol. To obtain the partial COI gene (658 bp), the sequences were amplified using the primers LCO1490 (GGTCAACAAATCATAAAGATATTGG) and HCO2198 (TAAACTTCAGGGTGACCAAAAAATCA) (Folmer et al. 1994). The composition of the PCR reaction mixture used was as follows: 5 μL of KOD One® PCR Master Mix -Blue- (TOYOBO, Japan), 0.3 μL (10 pmol/μL) of each of the forward and reverse primers, and 1.0 μL of template DNA, with Milli-Q water added to a final volume of 10 μL. PCR amplification was performed using the following program: an initial denaturation at 98 °C for 10 s, followed by 35 cycles at 98 °C for 10 s,

Table 1. Names and collection localities for the taxa used in phylogenetic analyses and calculating genetic distances.

Species	Country	Site	Accession No.	Sample ID
Morophaga hahajimana sp. nov.	Japan	Hahajima Is. Sakaigatake	LC832846	JHP-193
M. hahajimana sp. nov.	Japan	Hahajima Is. Nishiura	LC832847	ELKU-I-L-Bonin 000068
M. hahajimana sp. nov.	Japan	Hahajima Is. Nishiura	LC832848	ELKU-I-L-Bonin 000069
M. bucephalla	South Korea	Weolag Mt.	KF523806	SWC-06-0211
M. choragella	Finland	Imatra	HM871460	MM02260
M. clonodes	Australia	Queensland	HQ948706	10ANIC-05055
M. formosana	Japan	Chichijima Is.	LC832853	JHP-137
M. formosana	Japan	Mukojima Is.	LC832849	JHP-194
M. formosana	Japan	Nakodojima Is.	LC832850	JHP-195
M. formosana	Japan	Aichi	LC260333	LC260333
M. formosana	China	Sichuan	OR793908	OR793908
M. formosana	China	Guangdong	OL639141	GE-2
M. formosana	China	Guangdong	OL639142	GE-1
M. parabucephalla	China	Guangdong	LC187277	LC187277
M. fasciculata	Japan	Fukuoka	LC848649	JHP-233
Amorophaga japonica	Japan	Fukuoka	LC020067	LC020067
Montescardia tessulatellus	Austria	Vorarlberg	KM572906	TLMF Lep 09191
Morophagoides moriutii	Japan	Ehime	AB905270	YO137
Scardia boletella	Germany	Bavaria	KX044545	BC ZSM Lep 61315
Scardiella approximatella	USA	North Carolina	GU090176	DNA-ATBI-0580
Erechthias zebrina	Japan	Chichijima Is.	LC832851	ELKU-I-L-Bonin 000082
Tinea pellionella	Italy	Piedmont	OQ181934	KLM Lep 15562

50 °C for 5 s, and 68 °C for 5 s. The amplified products were purified using ExoSAP-IT™ Express (Thermo Fisher Scientific Inc., USA), and cycle sequence reactions and bidirectional sequencing were conducted at Pre-mixed Sanger sequencing services (Azenta Japan Corp., Japan).

Phylogenetic analysis

For constructing the preliminary maximum likelihood (ML) trees and maximum parsimony (MP) trees, the partial COI mitochondrial genes were analyzed using MEGA 11.0.13 (Tamura et al. 2021). For the phylogenetic analysis, the best substitution models for the data set were selected using a Find Best-Fit Substitution Model (ML) test in MEGA 11.0.13 (Tamura et al. 2021). After model selection, a general time-reversible model with a discrete gamma distribution with five rate categories and assuming that a certain fraction of sites is evolutionarily invariable was selected.

The sequences of four *Morophaga* species, five Scardiinae species, and one Tineinae species (used as an outgroup) were downloaded from GenBank (Table 1). In summary, 14 Operational Taxonomic Units (OTUs) with 14 species, including *M. hahajimana* sp. nov. (LC832848), *M. formosana* (LC832853), *M. fasciculata*, and *E. zebrina* were analysed. Branch support was calculated using 1,000 bootstrap replicates. To identify closely related species, COI sequences were searched against the mitochondrial nucleotide database of the BOLD identification system (Ratnasingham and Hebert 2007). To clarify the intra- and interspecific genetic diversity of *M. hahajimana* sp. nov. and *M. formosana*, uncorrected pairwise distances were calculated in MEGA 11.0.13 (Tamura et al. 2021). Ten specimens (*M. hahajimana*: three, *M. formosana*: seven) from Japan and China were used in the analysis, including four OTUs of *M. formosana* downloaded from GenBank (Table 1).

Results

Taxonomy

Morophaga hahajimana Park, Yagi & Hirowatari, sp. nov.

https://zoobank.org/2F921DE9-72A4-417E-8D60-30A1215D61CD

Japanese name: hahajima-oohirozukoga

Diagnosis. The new species was found to be exteriorly similar to *Morophaga choragella* ([Denis & Schiffermüller], 1775), but it can be distinguished by the following characteristics: the anterior half of the basal 1/3 is brown in the forewing (only a small spot in *M. choragella*); the gently concaved uncus, ventral margin of valva is not divided and has tough bristles basally, and the phallus has two or three lobate carinae in the male genitalia. The genitalia are similar to those of *M. fasciculata* and *M. plana*, but can be distinguished by the following characteristics: the shape of the valva is rectangular, without deep emargination in the male genitalia; the ostium is tighter and weakly concaved, and the ductus bursae is relatively short in the female genitalia.

Description. Male (Figs 1, 2, 5, 7). Forewing length 9.7 mm, antennae length 5.3 mm in holotype, forewing length 6.0–8.9 mm ($n = 4$), antennae length 4.3–5.3 mm ($n = 3$) in paratypes. Head ochreous white, vertex brown. Antenna ciliate, scape and pedicel ochreous white, anterior margin brown; flagellomere covered with ochreous white scales dorsally, and with more than 10 bristles ventrally. Labial palpus ochreous white, upwardly directed; outer surface of first and second palpomere dark brown; second palpomere densely with brown bristles at under side, and outer surface with 7–9 black bristles; outer surface of third palpomere with dark brown spot. Thorax and tegula ochreous; posterior half of tegula and posterior 1/3 of thorax ochreous white. Forewing venation with Sc, R1–5, M1–3 CuA1–2, CuP, and 1A+2A present; R1 from basal 2/5 of cell, to apical 1/3 of costa; R3 and R4 stalked; R5 reached to costal margin near apex; 1A fused with 2A from basal 1/3 to end. Forewing ground colour ochreous white, scattered with small brown dots, and brown to black spots; basal 1/3 with trapezoidal to rounded black triangle spot, not reaching dorsal margin; dark brown band elongated from apical 2/3 of costa to center of sub-marginal area; apical area with one large trapezoidal spot at costal margin near apex and 2–4 dots at termen, each spot sometimes connected to dark brown band; posterior margin broadly scattered with ochreous to brown scales; R3 to M3 veins with light brown scales; cilia line distinct, dark brown to ochreous; cilia black to ochreous white. Hindwing with all veins present, Sc+R1 and Rs connected by irregularly right-angle vein near base. Hindwing trapezoidal, costal margin subapically concaved; ground colour ochreous grey, apex with one or two brown spots; each vein brown; marginal area fringed with brown scales; cilia ochreous white, apex and anterior margin with few brown scales. Abdomen covered with ochreous or brown scales. Segment VIII with coremata; sternite VIII broadly rectangular; coremata invaginated into shallow pouches at intersegmental membrane; anterior 1/3 of tergite VIII broad trapezoid, posterior 2/3 rectangular.

Male genitalia (Figs 8–11). Vinculum fused with tegumen, forming a narrow ring. Saccus shield-shaped, strongly sclerotized. Uncus roughly covered with short setae; gently split and forming a pair of tongue shaped lobes. Gnathos absent. Subscaphium simple, a narrow ribbon shaped. Valva rounded rectangular, thickened plate, roughly covered with long bristles; apical half strongly sclerotized, densely with small spines, especially apicoventrally, basoventral 1/3 of inner surface with bunded tough hairs; dorsal margin almost straight, apex sharply curved toward ventral side;

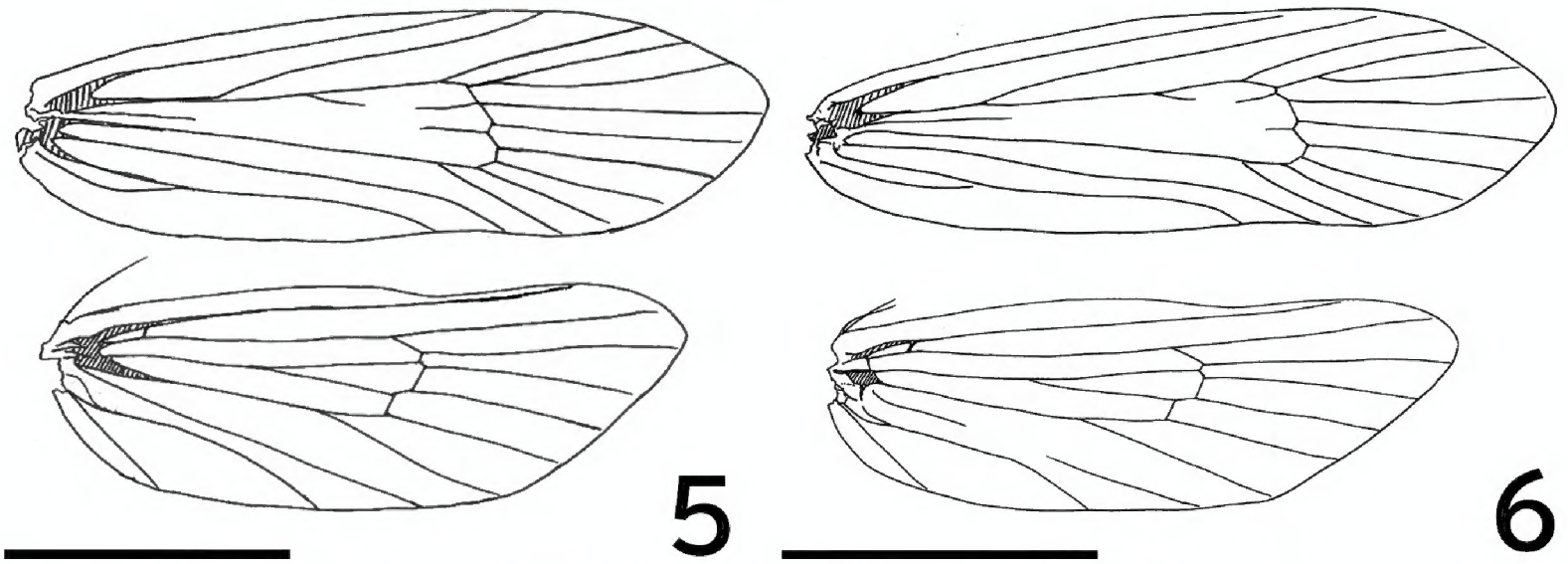
Figures 1–4. Adults **1–3.** *Morophaga hahajimana* sp. nov. **1.** Holotype, male, genitalia slide no. JP-275; **2–3.** Paratypes; **2.** Male, JP-303; **3.** Female, DNA sample ID ELKU-I-L-Bonin 000068; **4.** *Morophaga formosana* Robinson, female, JP-302. Scale bars: 8.0 mm.

ventral margin slightly concaved at middle; small triangular lobe apically with four to six spines located at apical 1/3 of inner surface; valval apodeme strong, finger-shaped; basodorsally with membranous lobe elongate, densely hirsute. Juxta thin, sclerotized. Phallus elongated horn-shaped, basally broad and rounded, tapering toward apex; apical 1/3 with two or three lobate carinae dorsally; subzonal sheath about 1/6 length of phallus with a trapezoidal lobe ventrally; suprazonal sheath about 5/6 length of phallus with membrane dorsally; cornuti absent.

Female (Figs 3, 6). Forewing length 7.3–10.5 mm ($n = 7$), antennae length 4.2–6.0 mm ($n = 3$) in paratypes. Almost all same as male. But antennae filiform.

Female genitalia (Fig. 16). Ovipositor long, 1.6× length of apophysis anterioris; apex with pair of roughly setose lobes. Sternite VIII trapezoidal, centre of posterior margin with pair of long setose, finger shaped lobes. Ostium located at centre of posterior margin of sternite VIII. Ductus bursae strongly sclerotized, tough cylindrical, 0.7× length of corpus bursae, and with 5–6 wrinkles from posterior end to posterior 2/3. Corpus bursae elongated piriform. Signum absent.

Type material. ***Holotype.*** ♂; [JAPAN, Tokyo Met., Ogasawara Isls.] Mt. Funaki-yama, Hahajima Is.; Host: white fungi; Host coll. on 17. iii. 2023; Emrg. on 27. iii. 2023; J.-H. Park leg.; genitalia slide no. JP-275; deposited in ELKU.



Figures 5, 6. *Morophaga hahajimana* sp. nov. wing vein **5.** Male, slide no. JP-266 **6.** Female slide no. JP-265. Scale bars: 3.0 mm.

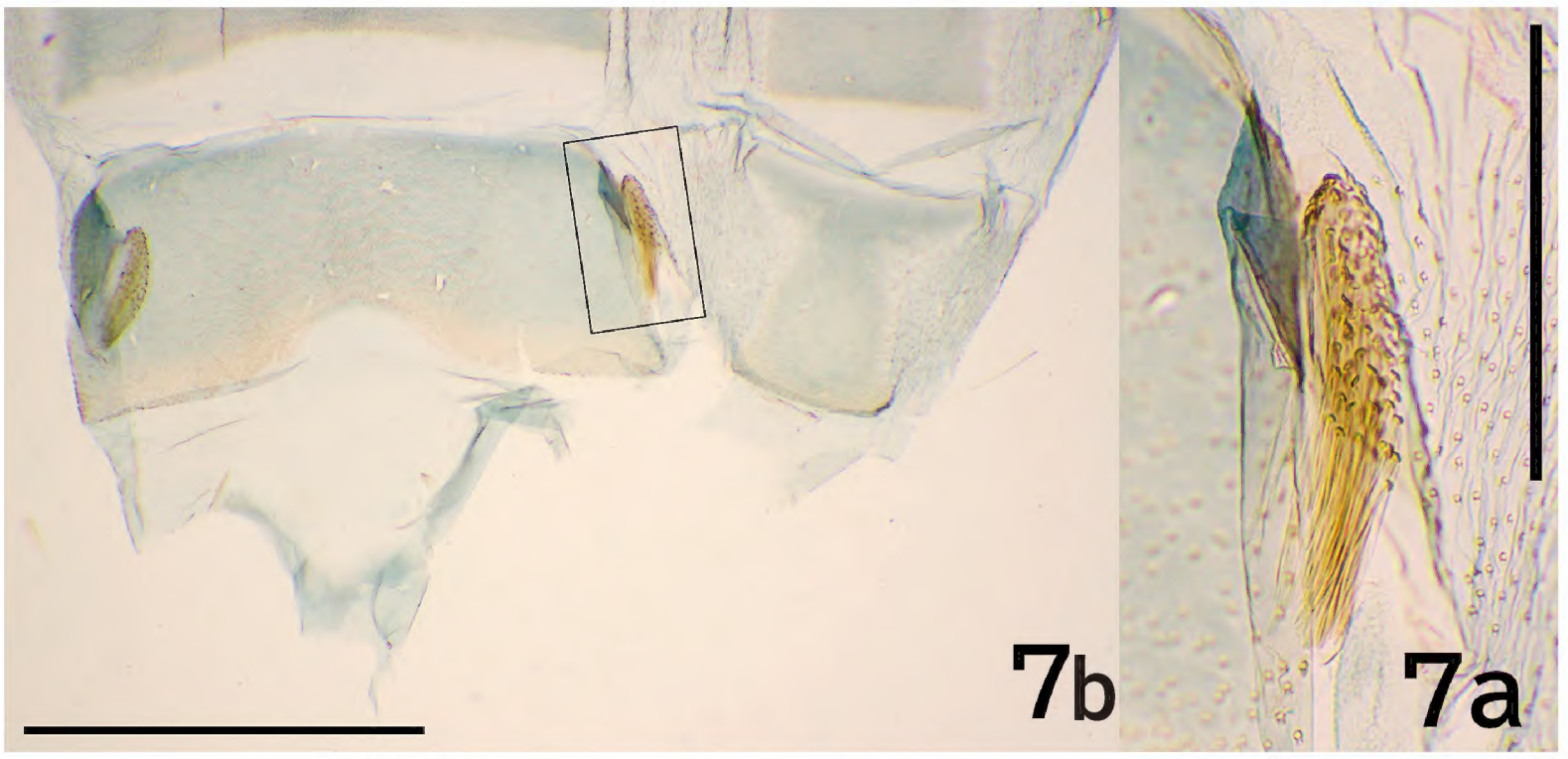
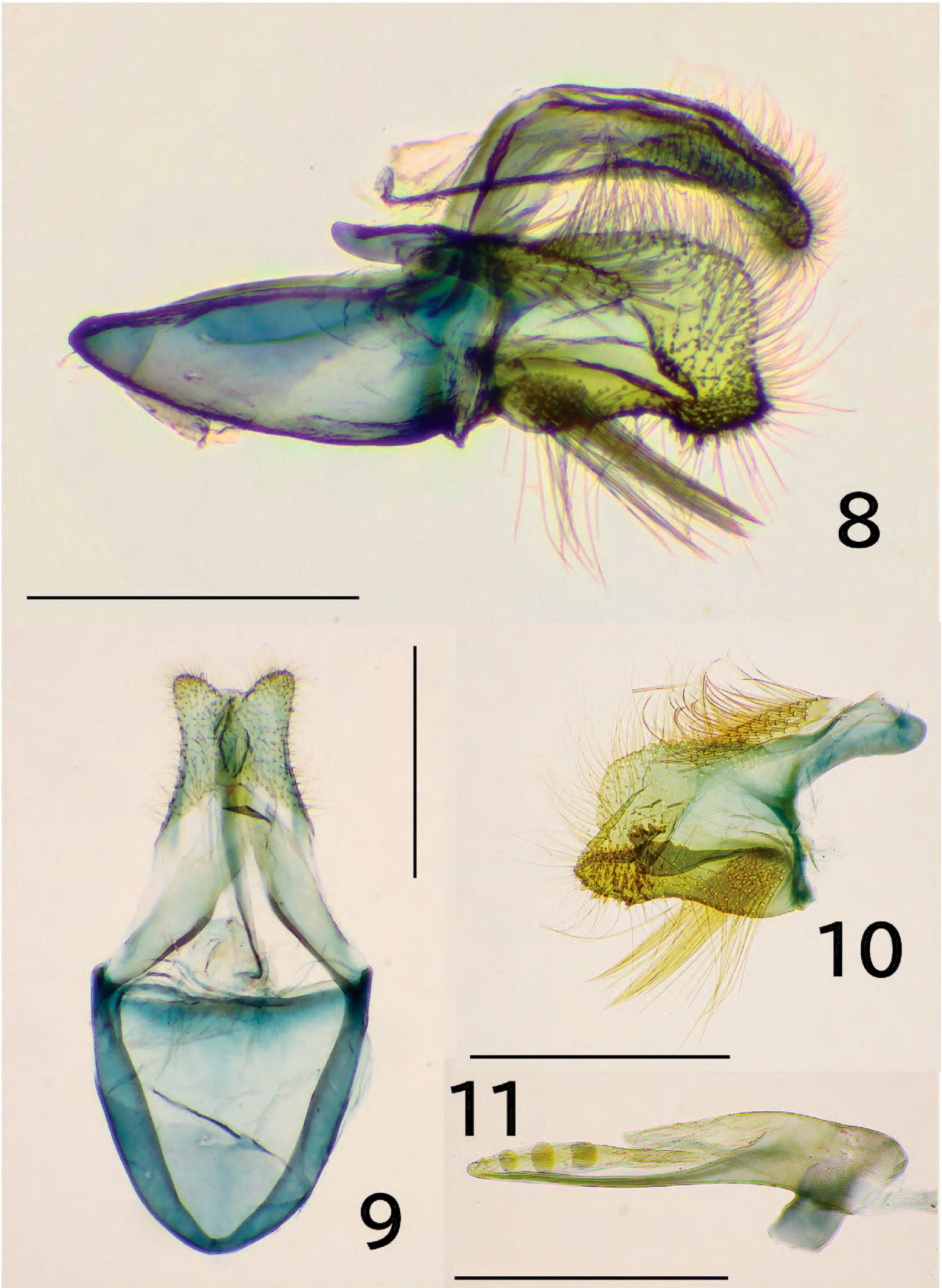


Figure 7. a. Coremata; **b.** *Morophaga hahajimana* sp. nov., eighth segment, genitalia slide no. JP-275. Scale bars: 1.0 mm (**a**), 0.3 mm (**b**).

Paratypes. [Hahajima Is.] • 2 ♂; Mt. Sakaiga-take, Haha-jima Is., Ogasawara Vill.; Host: white fungi with moss; Host coll. on 2023. vi. 17; Emrg. on 2023. vii. 1; J.-H. Park leg.; DNA sample JHP-193 ELKU • 1 ♀; Nishiura, Hahajima Is., Ogasawara-mura; 174 m; 21. vi. 2022; S. Tomura leg.; DNA sample ELKU-I-L Bonin 000068; ELKU • 1 ♀; Nishiura, Hahajima Is., Ogasawara-mura; 174 m; 21. vi. 2022; S. Yagi, T. Hirowatari, S. Tomura, M. Kimura leg.; genitalia slide no. JP-267; DNA sample ELKU-I-L Bonin 000069; ELKU • 2 ♀; Shinyûhigaoka, Hahajima Is., Ogasawara-Vill.; 14. vi. 2023; LT; J.-H. Park leg.; ELKU • 2 ♀; Mt. Chôki-yama, Hahajima Is., Ogasawara-Vill.; 15. vi. 2023; LT; J.-H. Park leg.; genitalia slide no. JP-269; ELKU • 1 ♀; Mt. Funaki-yama, Hahajima Is., Ogasawara-Vill.; Host: white fungi; Host coll. on 17. iii. 2023; Emrg. on 24. iii. 2023; J.-H. Park leg.; ELKU • 2 ♂; Mt. Funaki-yama, Hahajima Is., Ogasawara-Vill.; Host: white fungi; Host coll. on 17. iii. 2023; Emrg. on 27. iii. 2023; J.-H. Park leg.; genitalia slide no. JP-303; ELKU • 1 ♂; Mt. Funaki-yama, Hahajima Is., Ogasawara-Vill.; Host: white fungi; Host coll. on 17. iii. 2023; Emrg. on 4. iv. 2023; J.-H. Park leg.; genitalia slide no. JP-046; wing slide no. JP-266; ELKU.



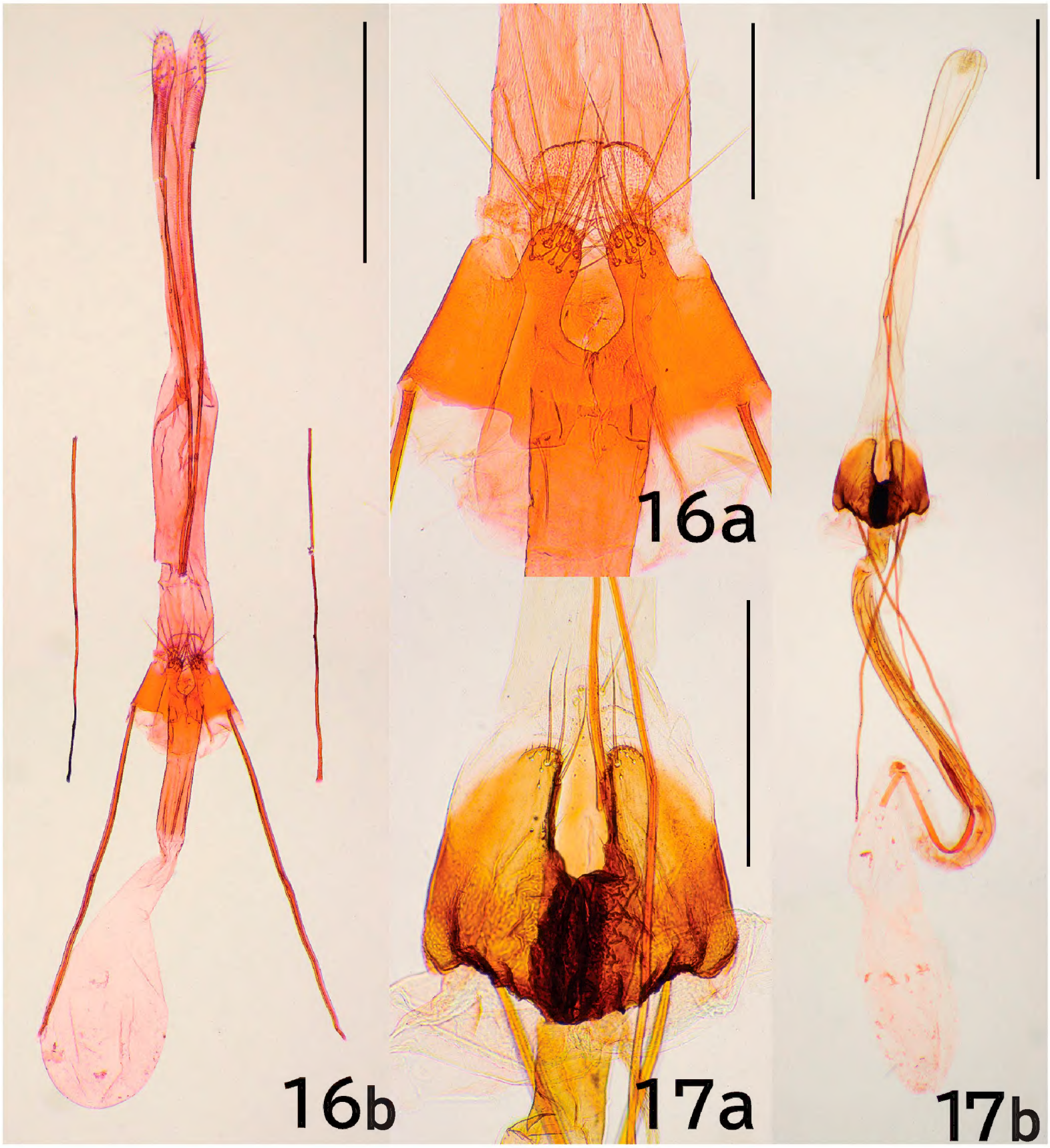
Figures 8–11. *Morophaga hahajimana* sp. nov., male genitalia, genitalia slide no. JP-275. **8.** Whole genitalia except phallus, lateral view; **9.** Uncus to saccus, dorsal view; **10.** Right valva, lateral view; **11.** Phallus lateral view. Scale bars: 0.5 mm.

Figures 12–15. *Morophaga formosana* Robinson, male genitalia **12–14** Genitalia slide no. JP-314; **12.** Whole genitalia except phallus, lateral view; **13.** Uncus to saccus, dorsal view; **14.** Right valva, lateral view; **15.** Phallus lateral view, JP-397. Scale bars: 0.5 mm.

Biology. Larvae bore into white fungi of the family Polyporaceae and fed on them (Figs 18, 20, 21). Two male specimens also emerged from fungi occurring on the mossy bark on Mt. Sakai-dake (Fig. 19), but the emerged adults were very small body sizes (Forewing length 6.0, 6.6 mm in Mt. Sakai-dake specimens (n = 2), 8.5, 8.9, 9.7 mm in other male specimens (n = 3)). A few adults were collected in June by using light traps.

Distribution. Japan (Haha-jima Is.).

DNA barcoding. Three DNA barcodes from one male and two females were generated and deposited in the DDBJ (accession numbers): LC832846 (male), LC832847, and LC832848 (female). The result for the blast analysis on the Bold systems yielded no similar sequences and the



Figures 16, 17. Female genitalia. **16a.** Segment VIII; **16b.** *Morophaga hahajimana* sp. nov., genitalia slide no. JP-269**,** whole genitalia, dorsal view; **17a.** Segment VIII; **17b.** *Morophaga formosana* Robinson, JP-302, whole genitalia dorsal view. Scale bars: 0.5 mm (**16a, 17a**); 1.0 mm (**16b, 17b**).

best ID was "no match". The intraspecific pairwise distances of this species were 0.15% to 0.31% (n = 3) (Table 2).

Etymology. The species name is derived from the type locality (Hahajima Island). because the distribution of this species is restricted to Hahajima Island.

Remarks. There were some variations seen in the forewing patterns of this species. It consists of an ochreous white ground colour, large brown to black dots, and scattered fuscous scales (Figs 1, 2, 22). In one specimen, the scattered dark brown dots of the forewing were barely marked (Fig. 3).

Figures 18–23. Biology and habitat of *Morophaga* species **18–21.** *Morophaga hahajimana* sp. nov. **18.** Habitat, Hahajima Is., Mt. Funaki-yama; **19.** Habitat, Hahajima Is., Mt. Sakaiga-take; **20.** Host fungi with larva, Hahajima Is., Mt. Funaki-yama; **21.** Host fungi with pupal exviae, Hahajima Is., Mt. Funaki-yama; **22.** Resting posture of the adult of *Morophaga hahajimana* sp. nov.; **23.** Resting posture of the adult of *Morophaga formosana* Robinson.

Morophaga formosana Robinson, 1986

Japanese name: madara-oohirozukoga

Morophaga formosana Robinson, 1986: 128, figs 74, 133, 137. Type locality Taiwan (Taihoku); Park and Whang 1990: 22, figs 1, 5–8; Sakai 2013: 119, fig. 3–11-6; Osada et al. 2016: 404, fig. 1a: 405, fig. 2a: 406, fig. 3, 4; Osada 2017: 104, figs 1A, 2, 3; Xu et al. 2022: 97, fig. 1: 98, fig. 2, 3; Hirowatari and Yagi 2023: 23.

Morophaga kobella Robinson, 1986: 133, figs 79, 177. Type locality Japan (Kobe). syn. by Park and Whang 1990.

Diagnosis. This species is exteriorly similar to *M. sistrata* (Meyrick, 1916), and *M. iriomotensis* Robinson 1986, but can be distinguished by the following characteristics: the row of cornuti on the vesica are broad on posteriorly and narrow on anteriorly (broad all over *M. iriomotensis*, and *M. sistrata*); the lamella antevaginalis is basally triangular (rounded in *M. iriomotensis*).

Description. (Figs 4, 12–15, 17, 23) ***Measurement.*** Forewing length 9.3–9.5 (n = 2) in males, 9.7–10.6 mm (n = 3). Antennae length 4.7–5.0 mm (n = 2) in males, 5.0–5.2 mm (n = 2) in females.

Wingspan 20.2–20.5 mm (n = 2) in males, 21.5–23.2 mm (n = 2) in females in Ogasawara Islands, 18.0 mm in male, 16.0 mm in female in original description.

More morphological information, see Robinson (1986) and Park and Whang (1990).

Material examined. [JAPAN, Tokyo Met., Ogasawara Isls.] • [Mukojima Is.] 1 ♀; 15. VII. 2024; J.-H. Park leg.; DNA sample JHP-194 • [Nakodojima Is.] 1 ♂, 3 ♀; Host: white fungi; Host coll. on 2024. VII. 16; Emrg. on 2024. VII. 24; J.-H. Park leg.; genitalia slide no. JP-314(♂); DNA sample JHP-195(♀) • [Ototojima Is.] 1 ♀; Mt. Tenkai-dake; 2024. VII. 12–13; LTFIT; J.-H. Park leg. • [Chichijima Is.] 1 ♀; Ôgamiyama Park; 13. vi. 2023; J.-H. Park leg.; genitalia slide no. JP-302; DNA sample JHP-137; ELKU • 2 ♂, 1 ♀; Kopepe beach; Host: White fungi; Host coll. on 13. VII. 2024; Emrg. on 2024. VII. 14; T. Hirowatari leg.

Biology. Larvae feed on *Ganoderma lucidum* (Leyss. ex. Fr.) Karst, *G. tsunodae* (Yasuda), *G. sinense* Zhao, Hsu & Zhang (Ganodermataceae), and *Inonotus mikadoi* (Lloyd) Gilbertson & Ryvarden (Polyporaceae) (Oasda et al. 2016; Xu et al. 2022). On the Ogasawara Islands, larvae feed on Polyporaceae white fungi. Adults were collected in June and July from the Ogasawara Islands, in July from Honshu, Japan (Sakai 2013), and in April and July from Taiwan (Robinson 1986).

Distribution. Japan (Honshu, Chichijima Is., Ototojima Is., Mukojima Is., Nakodojima Is.) Korea, China, and Taiwan).

Table 2. Genetic distances of the partial COI gene sequences of *Morophaga hahajimana* sp. nov. and *M. formosana*. Genetic distances (uncorrected pairwise distances, %) were calculated using MEGA 11.

	1. *Morophaga hahajimana* sp. nov. LC832846/ Hahajima Is., Sakaigatake	**2. *Morophaga hahajimana* sp. nov. LC832848/ Hahajima Is., Nishiura**	**3. *Morophaga hahajimana* sp. nov. LC832847/ Hahajima Is., Nishiura**	**4. *Morophaga formosana* LC832853/ Chichijima Is.**	**5. *Morophaga formosana* LC832850/ Nakodojima Is.**	**6. *Morophaga formosana* LC832849/ Mukojima Is.**	**7. *Morophaga formosana* OR793908/ China, Sichuan**	**8. *Morophaga formosana* OL639142/ China, Guangdong**	**9. *Morophaga formosana* OL639141/ China, Guangdong**	**10. *Morophaga formosana* LC260333/ Japan, Aichi**
1		0.15	0.15	9.62	9.62	9.62	9.62	9.47	9.47	10.70
2			0.31	9.77	9.77	9.77	9.77	9.62	9.62	10.86
3				9.62	9.62	9.62	9.62	9.47	9.47	10.70
4					0.00	0.00	0.76	0.76	0.76	1.38
5						0.00	0.76	0.76	0.76	1.38
6							0.76	0.76	0.76	1.38
7								0.61	0.61	2.14
8									0.00	2.14
9										2.14
10										

DNA barcoding. Three DNA barcodes from females were generated and deposited in the DDBJ (accession numbers: LC832853, LC832849, and LC832850). The sequences of Ogasawara Islands were completely matched (n = 3), and intraspecific pairwise distances of this species between Ogasawara Island specimens and Honshu (LC260333) and Chinese specimens (OR793908, OL639142, OL639141), were 0.76–1.38% (n = 7) (Table 2).

Discussion

Morophaga hahajimana sp. nov. is similar to *M. plana* from Hokkaido, Japan, and *M. fasciculata* from Honshu, Japan, in forewing pattern and genital features (not divided at the posterior apex in the valva and phallus curved, lobate carinae present in males; anterior margin of sternite VIII with one pair of finger-shaped lobes in females). Similar species belong to the *choragella*-group suggested by Robinson (1986). Preliminary molecular phylogenetic analysis also showed that *M. hahajimana* sp. nov. is sister to *M. fasciculata*; therefore, it is possible that this species belongs to this group (Fig. 24). However, the new species does not have a hook-shaped articulated process in the valva, which is referred to as a conspicuous autapomorphy of the *choragella*-group (Robinson 1986).

In contrast, the genus *Morophaga* emerged as paraphyletic to *Diataga* Walsingham, 1914 and *Amorophaga* Zagulajev, 1968 (Robinson 1986). Our preliminary phylogenetic tree also indicated non-monophyly of *Morophaga*, although bootstrap values were < 75%. Additional research is needed to elucidate the phylogenetic relationships of this genus.

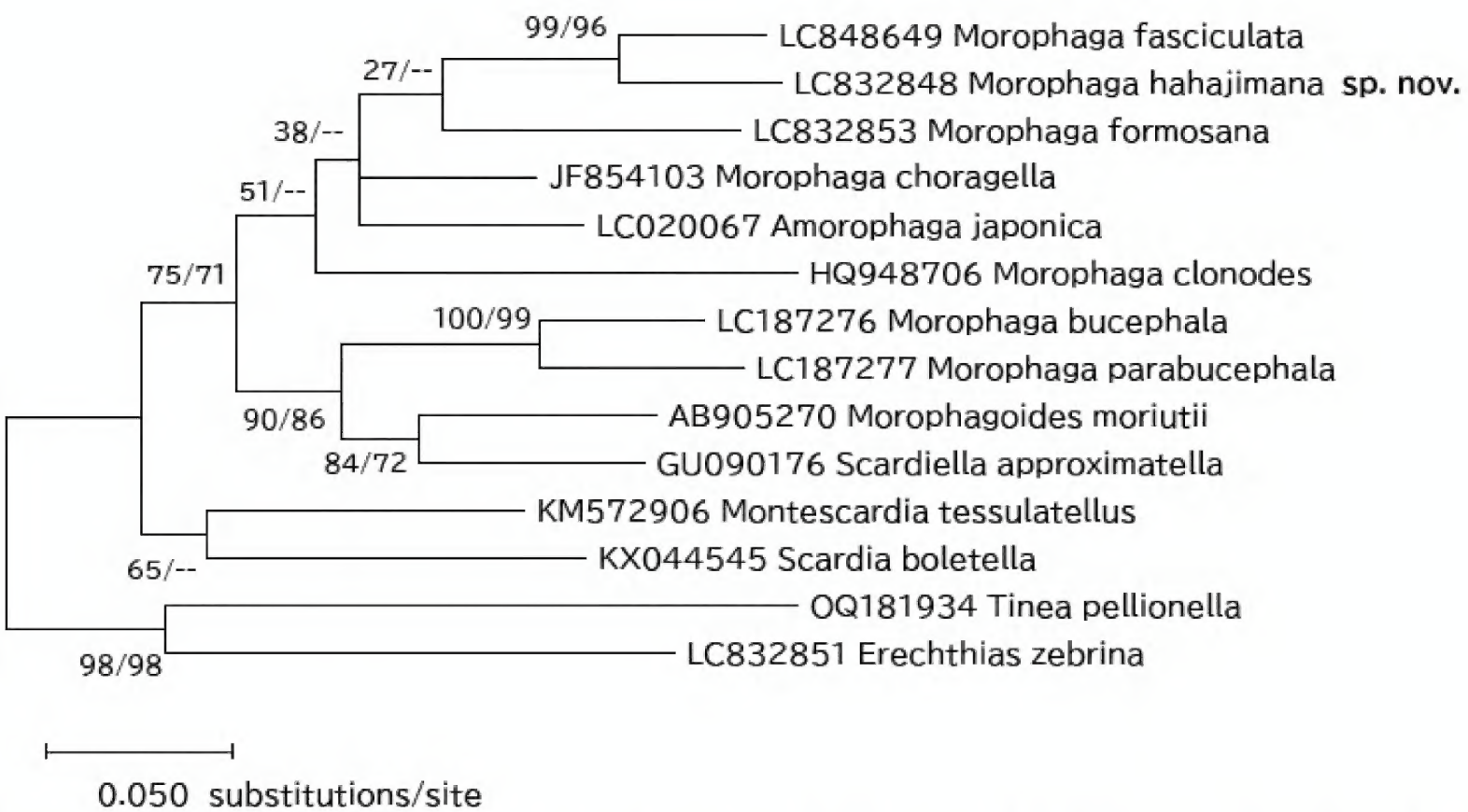


Figure 24. Maximum likelihood (ML) tree of Scardiinae constructed by MEGA 11 based on the partial COI region. The number near the node is the bootstrap value (ML/MP). Nodes annotated by "--" are where the topology did not match between the ML and MP methods. Branch lengths are proportional to the genetic distances and the scale bar indicated 0.05 substitutions/site.

This new species emerged from Polyporaceae fungi, which are widely found on the Ogasawara Islands. These white fungi are also found on Chichijima Island, Mukojima Island, and Nakodojima Island, but only *M. formosana* was collected from these islands. This non-overlapping distribution pattern may have been caused by the geographic origin and invasion route of this genus; however, further research is required to confirm this.

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